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TEST AND EVALUATION OF MODIFIED HIGH PERFORMANCE JET AIRCREW LI--ETC(U)
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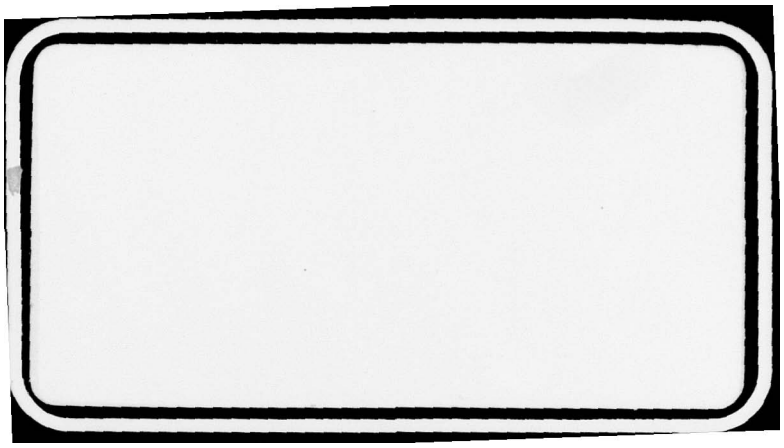

(3) LEVEL II

(11) NOVEMBER 1978

(9) DCIEM Technical Report, No. 78X36

AD A063959

(6) TEST AND EVALUATION OF
MODIFIED HIGH PERFORMANCE
JET AIRCREW LIFE PRESERVER.

(12) 22 p.

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(14) DCIEM-TR-78X36

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ABSTRACT

At the request of NDHQ, DCIEM evaluated several proposed Automatic Inflation Device (AID) pocket modifications for the high performance jet aircrew life preserver. Two Irvin proposals and two modified pockets developed at DCIEM were compared with the existing AID pocket in terms of manual pull force and automatic inflation times. Although no significant differences were noted between the four prototypes, an improved AID pocket resulting from DCIEM/DAES collaboration was considered best suited for CF use.

INTRODUCTION

The High Performance Jet Aircrew Life Preserver (NSN 4220-21-871-6316) was introduced into Canadian Forces service in February 1977. One of its' design features is an Automatic Inflation Device (AID), located on the front lower right side of the preserver and covered by a pocket designed to allow easy installation and removal of the AID for maintenance. When the AID is immersed in water, an electronic logic circuit, capable of distinguishing high humidity and splash from submergence, initiates an explosive cartridge to commence the automatic inflation sequence. The AID consists of manual and automatic modes for actuation, with manual inflation the preferred mode for emergency use (CFTO C-22-100-000/MF-000 Part 8 para. 2).

Since introduction, operational use of this life preserver has revealed two problem areas, interim solutions for which are covered by CFTO's C-22-100-000/CF-014 and C-22-100-000/CF-015. These deficiencies were:

a. An inadvertent inflation of a rain-soaked life preserver in a jet fighter aircraft cockpit during flight. (Subsequent investigation of the incident indicated that a probable cause was AID activation from pooled rainwater within creases of life preserver during aircraft manoeuvers).

b. Premature wear points on the life preserver buoyancy chamber. (DAES 4 analysis indicated the wear was due to contact between the AID, lap belt and the life preserver).

As a possible long term solution to these problems, the life preserver AID pocket has been redesigned by the manufacturer and preliminary prototypes have been manufactured. The design criteria for the prototype AID pocket included:

a. Improved rain protection for the AID.
b. Improved wear protection.
c. Easy installation on existing life preservers.

Project DAES 4370 tasked DCIEM/MLSD/LSE Section to test and evaluate a quantity of life preservers after completing modifications to incorporate the prototype AID pockets. Tests were also to be conducted in conjunction with a standard life preserver, high performance jet aircrew, which would be utilized to provide an evaluation performance baseline. The prototype AID Pockets were supplied direct from the manufacturer. At

NDHQ/DAES 4 request, AMDU Trenton supplied six Automatic Inflation Devices (Training AID NSN 6910-21-871-5184) to compliment LSE Section Resources for these evaluations. (For test purposes the AID'S were numbered 1 to 10). The life preservers were supplied by DAES 4. Other resources, i.e. 12 gm CO_2 cylinders and refurbishing kits for the AID were obtained, after some delay, through CF supply channels.

Objectives

The objectives of the tests were:

a. To determine the effect, if any, of the prototype AID pocket on the AID manual operating pull force.
b. To determine the effect, if any, of the prototype AID pocket on the automatic operation of the AID.

METHOD

Life Preserver Modification

On receipt of six each of two different prototype AID pockets, a careful inspection of the item was conducted. These pockets differ in configuration from the original AID pocket and were designated by LSE Section, for test purposes, Pocket A and Pocket B (Figure 1, 2 and 3).

Pocket A - Irvin P/N XID-88-119-3

The top, left and right sides and upper half of the front are integral and sewn to the AID pocket installation patch (7-8 stitches to the inch). The lower half of the AID pocket has a closure flap (an extension of the lower left side of pocket) which goes across the AID and is secured to the lower right side of the pocket with velcro hook/pile. The bottom of the pocket is integral with the sides. The overall configuration resembles a rectangular box with the bottom edge of the lower flap open to allow water entry. An interior leather patch approximately 3/4" in depth reinforces the inside bottom, front, back and sides of the pocket.

Pocket B - Irvin P/N XID-88-119-1

This pocket is similar to Pocket A except that the lower half of the front closure flap is secured to the lower right side and the bottom of the pocket with velcro hook/pile, the overall configuration resembling a closed rectangular box.

Note: Both pockets A and B have a 3/4" deep folded flap sewn across (1/4" below) the upper edge of the lower half of the front closure flap.

Because the folded flap sewn across the upper edge of the lower half of the front closure flap could be positioned in two ways, tests with the prototype AID pockets were conducted with this flap out, then with the folded flap in, to determine if any decrement in AID performance was evident.

Pocket C - MLSD Modifications

Another pocket A was reconfigured by LSE Section by opening up the left side, adding velcro hook/pile for securing purposes, then tucking in and sewing the folded flap so that the front of the AID pocket was continuous, top to bottom and would offer more rain protection. It was postulated that if the folded flap remains out any surface rain on the pocket could run down inside and possibly activate the AID. This pocket was designated C. The original AID pocket on the life preserver, high performance jet aircrew (used as a control during tests) was designated D (Figure 4).

Pocket E - MLSD/DAES' Prototype

At a late stage during the tests, after discussion with the NDHQ project officer, another pocket A was reconfigured and designated pocket E. This was effected by removing all except 1/2" of the top flap, the whole of the bottom flap, sewing a 5" x 4 1/2" finished flap to the top front flap (1/2" portion), adding velcro pile/hook to left and right side of flap and pocket (Figure 5 and 6). This again was an attempt to provide increased rain protection and ease of AID installation/removal during maintenance.

The modification to the life preservers was accomplished without difficulty by removing the original AID pocket securing patch, using minute quantities of toluene solvent to soften the adhesive, then peeling off the patch. The area was cleaned with solvent and allowed to air dry. The modified AID pocket securing patch was then affixed to the original securing patch position using Bostick adhesive 1125A. No deterioration of the life preserver fabric was evident after using the solvent.

Life Preserver Configuration

For the pull force tests and water entry tests, the test life preserver configurations were:

No. 1 - Prototype AID Pocket A
No. 2 - Prototype AID Pocket B

No. 3 - Prototype AID Pocket C
No. 4 - Current Life Preserver - 6316 Pocket D (Control)
No. 5 - Prototype AID Pocket E

Pull Force Tests

Tests were conducted using a spring balance (fish scale) to measure the pull force (pounds) required to activate the AID manual Operating lever to obtain full life preserver inflation. The manual operating lever was witness wired to the AID body using 0.020 inch soft copper wire as per CFTO C22-363-000/MF000 Part 3 d. This witness wire breaks at 12 pounds pull. The spring balance was connected to the manual operating lever and on all tests 45^{o} - 90^{o} pulling arc was established as the best angle of pull. The life preserver was secured to a work bench, AID pocket upwards, so that no movement was possible when the pull force was applied to the AID manual operating lever (Fig. 7, 8). Three pull tests were applied to each pocket configuration in order to establish a mean average pull force. Alternate AIDS were used for each pull test, so that no test would be compromised by a CO_2 cooled AID body and cam assembly.

Water Entry Tests

Water entry tests were conducted at the CF Base Toronto Swimming Pool Training AIDS NSN 6910-21-871-5184 were used to achieve automatic inflation of all life preservers being tested. The test subjects were dressed in combat flying suits, flying boots, DH 41-2 helmet/MK II Pate Suspension and O_2 mask. The life preservers were worn over the flying suit and under a flexible back parachute harness, modified for water entry. Different subjects participated in the water entry tests, jumping feet first into the deep water end of the pool from a height of approximately 6 feet.

During the early stages of water entry trials, problems were encountered with the refurbished training AIDS NSN 6910-21-871-5184 in that insufficient gas pressure was being generated by the fired cartridge primer (NSN 1377-21-871-7496) to properly operate the AID CO_2 cylinder piercing pins. Poor or no life preserver inflation resulted. DAES 4 were informed of the problem and requested AMDU Trenton to investigate. The investigation in conjunction with the AID manufacturer revealed the source of the problem and immediate remedial action was taken (message DAES 4860 271500Z FEB 78). Subsequently, three each water entry tests were completed with all the life preservers having the modified AID Pockets (two only were conducted with Pocket E due to a shortage of cartridge primers for the AID). Three water entries were also conducted

with the control life preservers, in order to determine time to full inflation of the life preserver on automatic mode in all instances.

Times to full inflation were based on the time taken from the subject's feet entering the water to subject on surface with a fully inflated life preserver.

RESULTS

Results of the tests are presented in Table 1 and Table 2.

DISCUSSION

AID pocket configurations A and B required a similar pull force to operate the AID manually (folded flap tucked inside). When this flap was positioned outside, a slightly stronger pull force was required to operate the AID manual lever. Pocket C allowed easy operation of the AID manual lever, as did the original AID pocket configuration (Pocket D) and pocket E.

It was determined during testing that pockets A, B and C did not permit easy AID installation or removal from the life preserver AID pocket. In order to position the AID the bottom of the pocket had to be distorted to overcome binding of the AID body on the life preserver Schraeder valve. As a consequence stripping of the valve threads might be possible. Should this occur during routine maintenance the AID could not be securely affixed to the life preserver which would become permanently unserviceable. This is considered important in terms of economical usage of a five year lifed item of life support equipment, and also in terms of servicing man hours.

Pocket D was initially approved by the design authority as an acceptable AID pocket when the life preserver-6316 was introduced by the manufacturer for testing. All tests conducted at that time indicated that the AID could be easily installed on or removed from the pocket. The design criteria for rain protection was considered to be met in pocket D. Subsequent operational use on one occasion, however, seemed to prove otherwise.

Pocket E permitted easy installation/removal of the AID from the life preserver due to the front closure flap design. It therefore meets the criteria for economical usage of a five year lifed item of life support equipment. Pockets A and B would not seem to meet the design criteria for increased rain

protection. It is considered that the folded flap sewn across the upper edge of the lower half of the front closure flap might present problems in terms of rain protection for the AID. It is easy to leave the flap OUT when it should be tucked IN thereby creating a possible area for rain water ingress.

Simulated 'heavy rain' tests were conducted whereby subjects wearing life preservers No. 1 and No. 2 (Pockets A and B, flaps tucked IN, flaps OUT) in both seated and standing postures, were sprayed with water from a hose fitted with a variable spray nozzle, over a five minute time frame. No inadvertent firing of the AID resulted. However, when each pocket configuration was examined after spraying, traces of water were found on the AID body in all instances. (The quantity of water was not sufficient to penetrate to the AID electronic logic circuit, fire the explosive squib and thus activate the CO_2 bottles to inflate the life preserver).

No similar tests were conducted with pocket C or pocket D. Discussions with the NDHQ project officer had precipitated pocket E. Pocket D was to be replaced.

A similar 'heavy rain' test conducted with pocket E failed to activate the AID. Examination of this pocket after testing revealed NO trace of water on the AID body. This would seem to confirm the hypothesis that product E by its design offers more rain protection potential than product A or B.

CONCLUSIONS

It is concluded that:

a) A difference in pull force is evident between the modified AID pocket configurations.

b) The difference is not considered sufficient to cause a problem on an operational emergency manual inflation of the life preserver.

c) The modified AID pockets tested do not reduce the time to inflation of the life preserver, high performance jet aircrew.

d) The modified AID pockets tested do not degrade the AID performance.

RECOMMENDATIONS

It is recommended that:

a) The design authority explore the feasibility of procuring several prototype AID pockets, based on the pocket E design.

b) The design authority supply these modified pockets to DCIEM for testing to confirm that the design criteria has been met in terms of rain protection and ease of AID maintenance.

REFERENCES

1. NDHQ letter 14220-102 (DAES 4) 30 Nov 77

2. CF specification CF-I-732

3. Irvin specification SCD-88-101

4. CFTO C22-363-000/MF-000

5. CFTO C22-100-000/MF-000 Part 8

6. CFTO C22-100-000/CF-014

7. CFTO C22-100-000/CF-015

8. NDHQ msg DAES 4860 271500Z Feb 78

9. DCIEM msg MLSD 34 131300Z Apr 78

Table 1: AID Manual Operating Lever Pull Force Tests

Life Preserver No.	AID Pocket Configuration	Pull Force (lb)	Mean Average (lb)
1	Pocket A-(Flap Inside)*	16-18 15-16 12-14	14-16
	Pocket A-(Flap Open)	16-18 16-18 14-16	15-17
2	Pocket B-(Flap Inside)	16-18 12-14 14-16	14-16
	Pocket B-(Flap Open)	16-18 16-18 16-18	16-18
3	Pocket C	14-16 11-16 16-18	13.6-16.6
4	Pocket D-(Control) (Original AID Pocket)	14-16 15-17 15-17	14.6-16.6
5	Pocket E	16-18 12-14 15-16	14-16

* Folded flap sewn across the upper edge of lower half of front closure flap.

Table 2: AID Performance on the Water Entry Tests

AID No.	Source	Cartridge Primer Lot No.	Cartridge Plug Length (inches)	Sleeve Pt No. 1122-034-01	Life Preserver No.	AID Pocket Configuration	Time To Full Inflation	Mean Average
1	DCIEM	HEP 8-2 12/74	0.325	Yes	1	A-Centre Flap Open*	3.2 sec	
10	DCIEM	HEP 10-2 12/75	0.325	Yes	1		2.5 sec	2.6 sec
1	DCIEM	HEP 10-1 12/75	0.325	Yes	1		2.0 sec	
5	AMDU	HEP 10-2 12/75	0.375	No	1	A-Centre flap inside	2.6 sec	
9	AMDU	HEP 10-2 12/75	0.375	No	1		2.8 sec	2.6 sec
10	DCIEM	HEP 10-2 12/75	0.325	Yes	1		2.4 sec	
3	DCIEM	HEP 8-2 12/74	0.325	Yes	2	B-Centre Flap Open	2.6 sec	
5	AMDU	HEP 10-1 12/75	0.375	No	2		3.0 sec	2.6 sec
2	DCIEM	HEP 10-2 12/75	0.325	Yes	2		2.2 sec	
4	AMDU	HEP 10-1 12/75	0.375	No	2	B-Centre Flap Inside	4.0 sec	
6	AMDU	HEP 10-2 12/75	0.375	No	2		2.2 sec	3.0 sec
10	DCIEM	HEP 10-2 12/75	0.325	Yes	2		2.8 sec	
6	AMDU	HEP 10-1 12/75	0.375	No	3	C-(LSE Section Mod.)	2.6 sec	
5	AMDU	HEP 10-1 12/75	0.375	No	3		3.0 sec	2.6 sec
3	DCIEM	HEP 10-2 12/75	0.325	Yes	3		2.2 sec	
2	DCIEM	HEP 10-1 12/75	0.325	Yes	4	D-(Control)	3.2 sec	
3	DCIEM	HEP 10-2 12/75	0.325	Yes	4		3.5 sec	3.0 sec
4	AMDU	HEP 10-2 12/75	0.375	No	4		2.4 sec	
7	AMDU	HEP 10-2 12/75	0.375	No	5	E-(LSE Section Mod)	2.0 sec	2.3 sec
8	AMDU	HEP 10-1 12/75	0.375	No	5		2.6 sec	

*Folded flap sewn across the uppper edge of lower half of front closure flap.

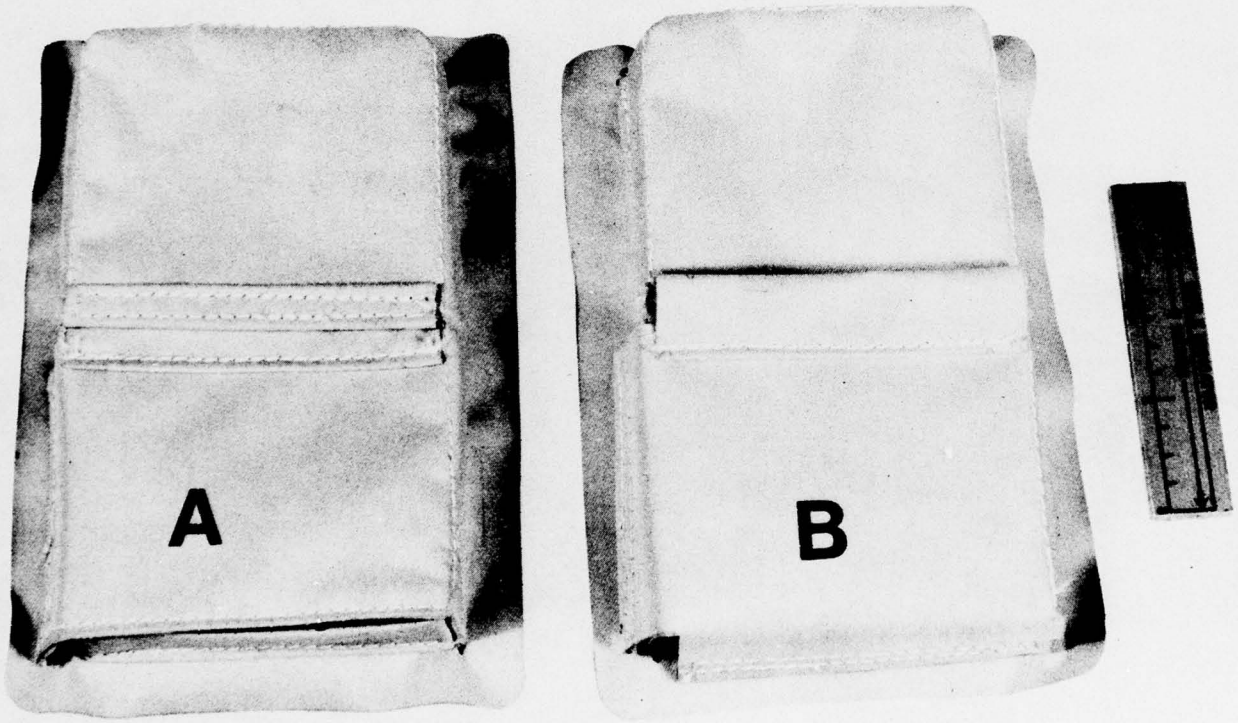

Figure 1: AID Pockets A and B (A has folded centre flap tucked in).

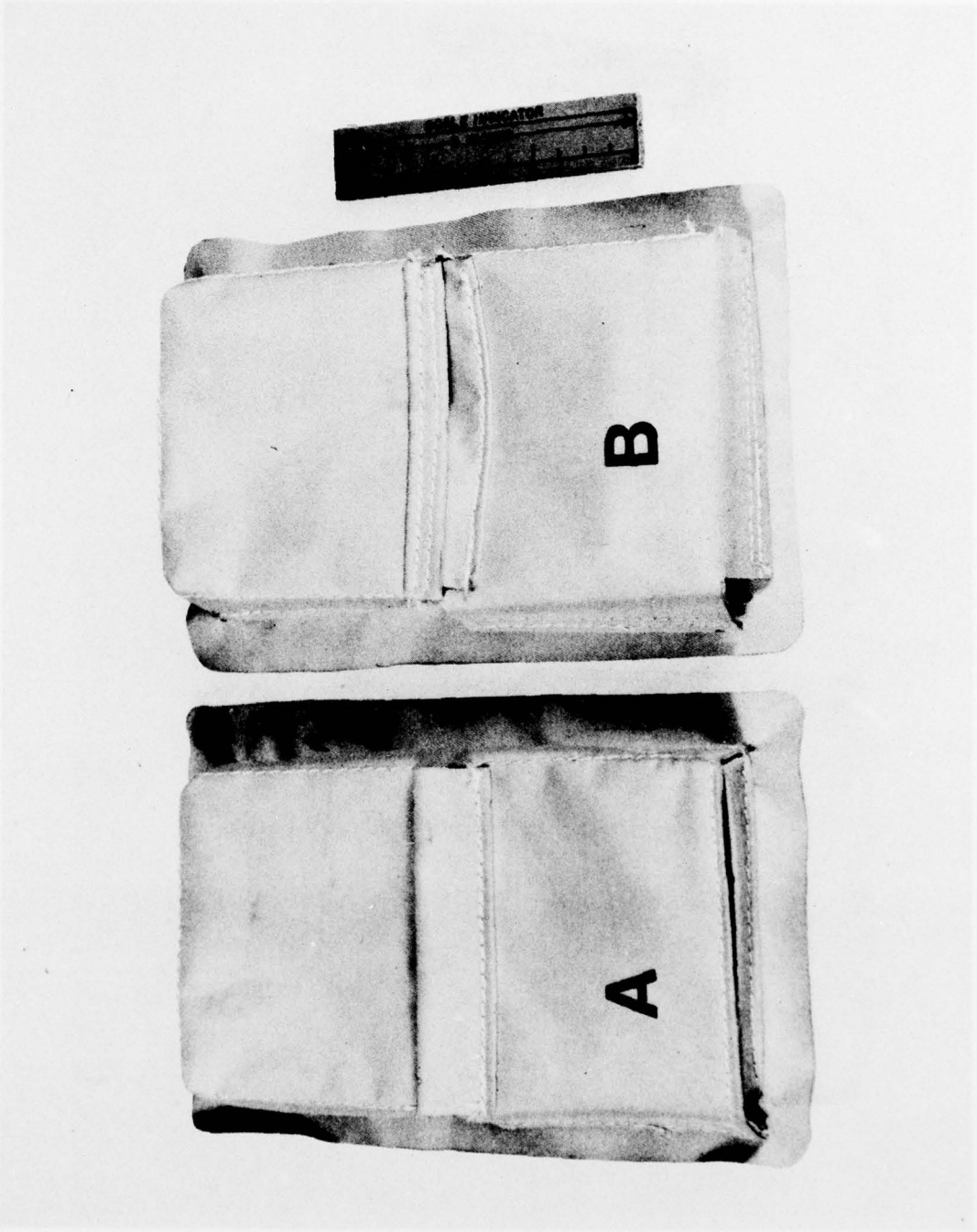

Figure 2: AID Pockets A and B (B has folded centre flap tucked in).

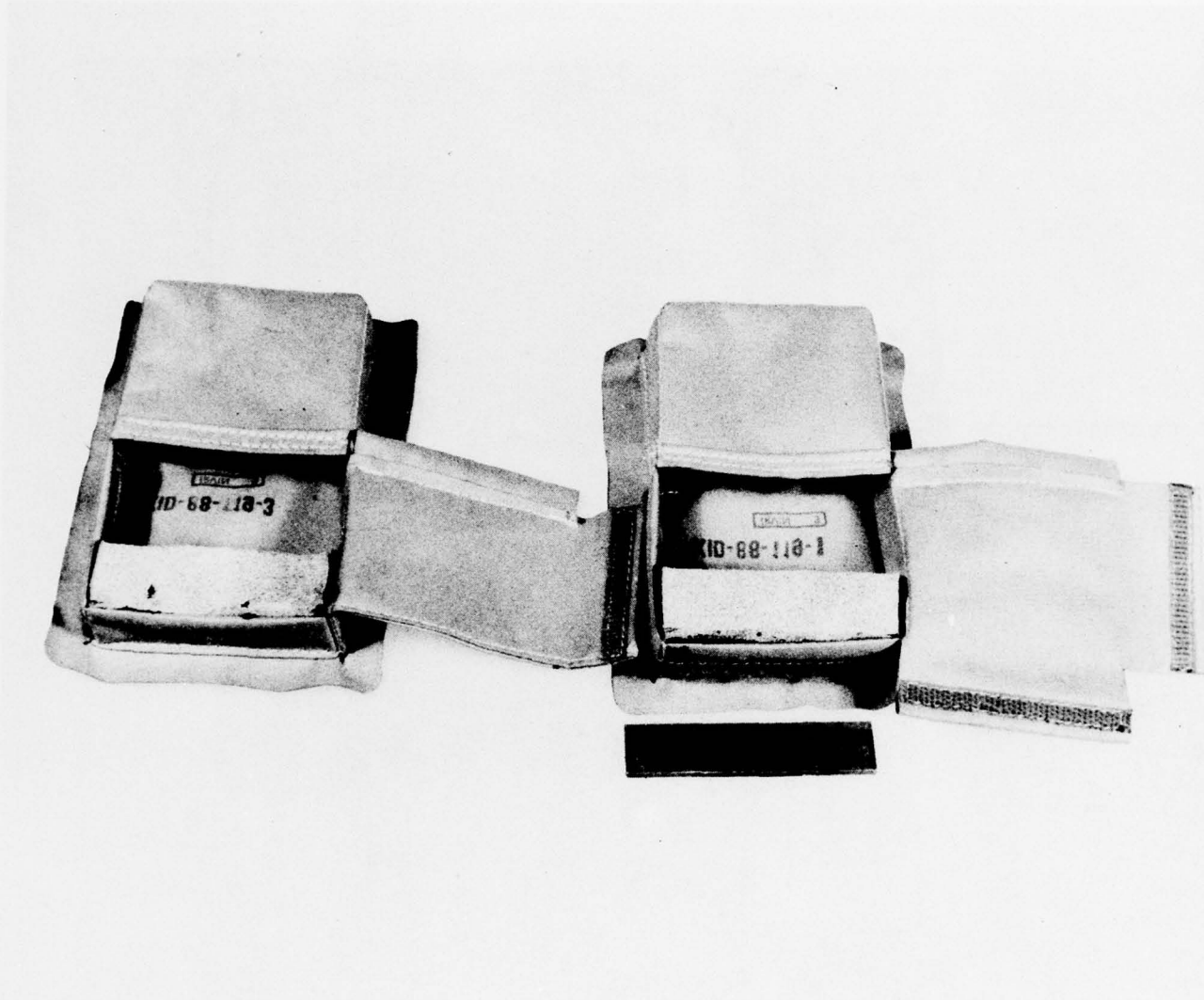

Figure 3: AID Pockets A and B (bottom front closure flaps open, showing interior and the reinforcing leather patch).

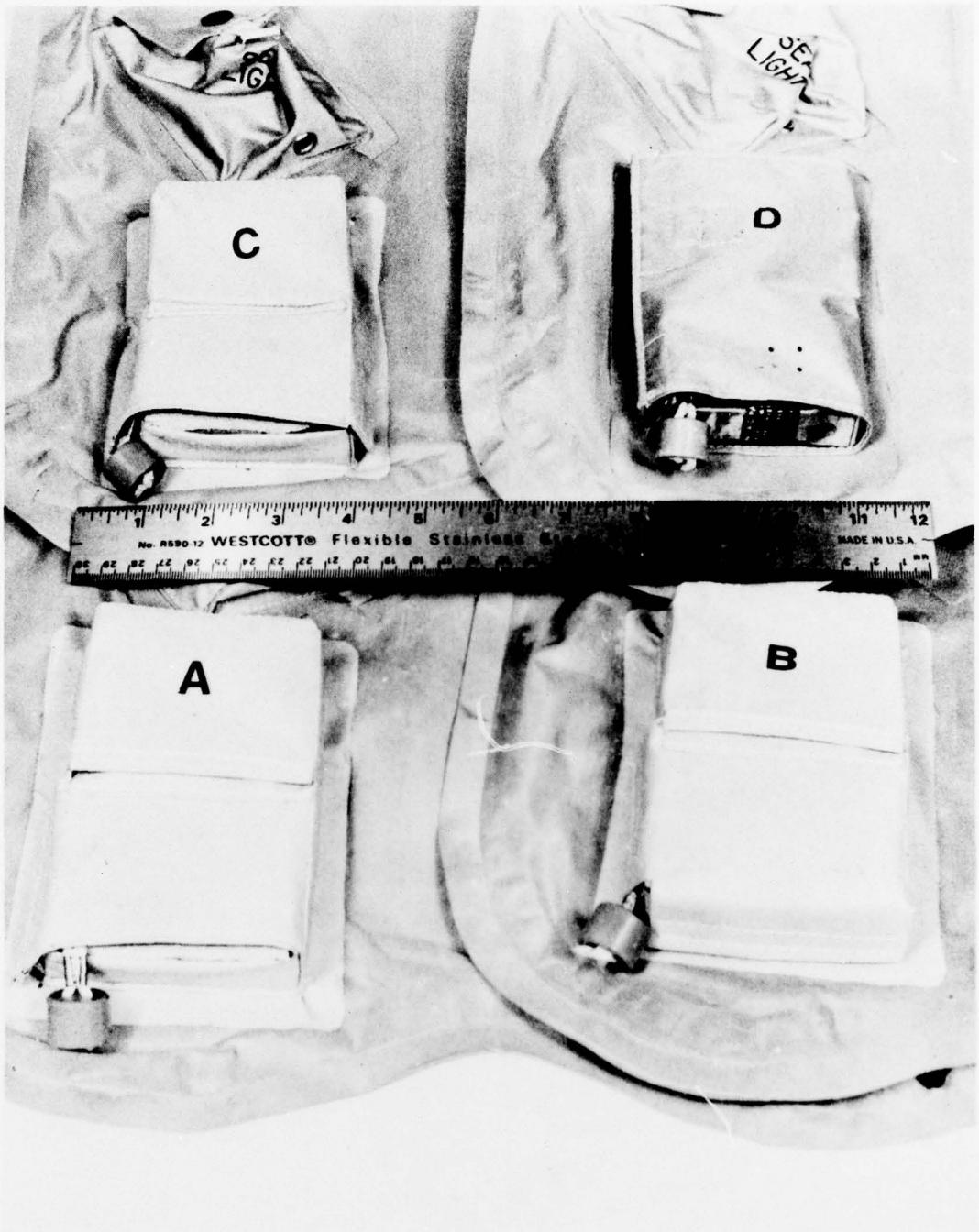

Figure 4: AID Pockets A, B, C and D (control) on life preservers NSN 4220-21871-6316.

Figure 5: AID Pocket E (pocket A modified by DCIEM/MLSD/LSE Section).

Figure 6: AID Pocket E (front closure flap open, showing the AID installed on life preserver).

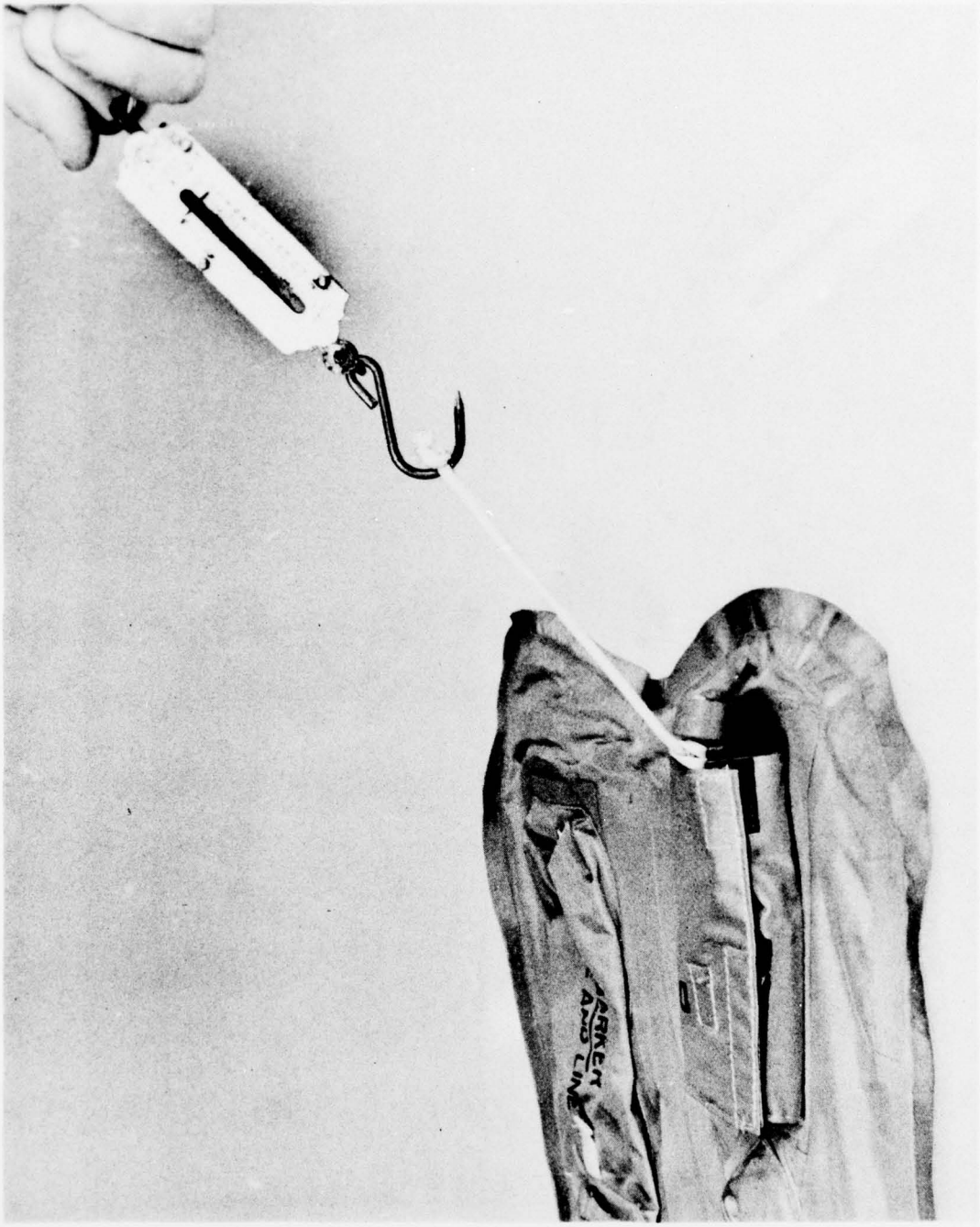

Figure 7: Pull force tests with spring balance (pocket D).

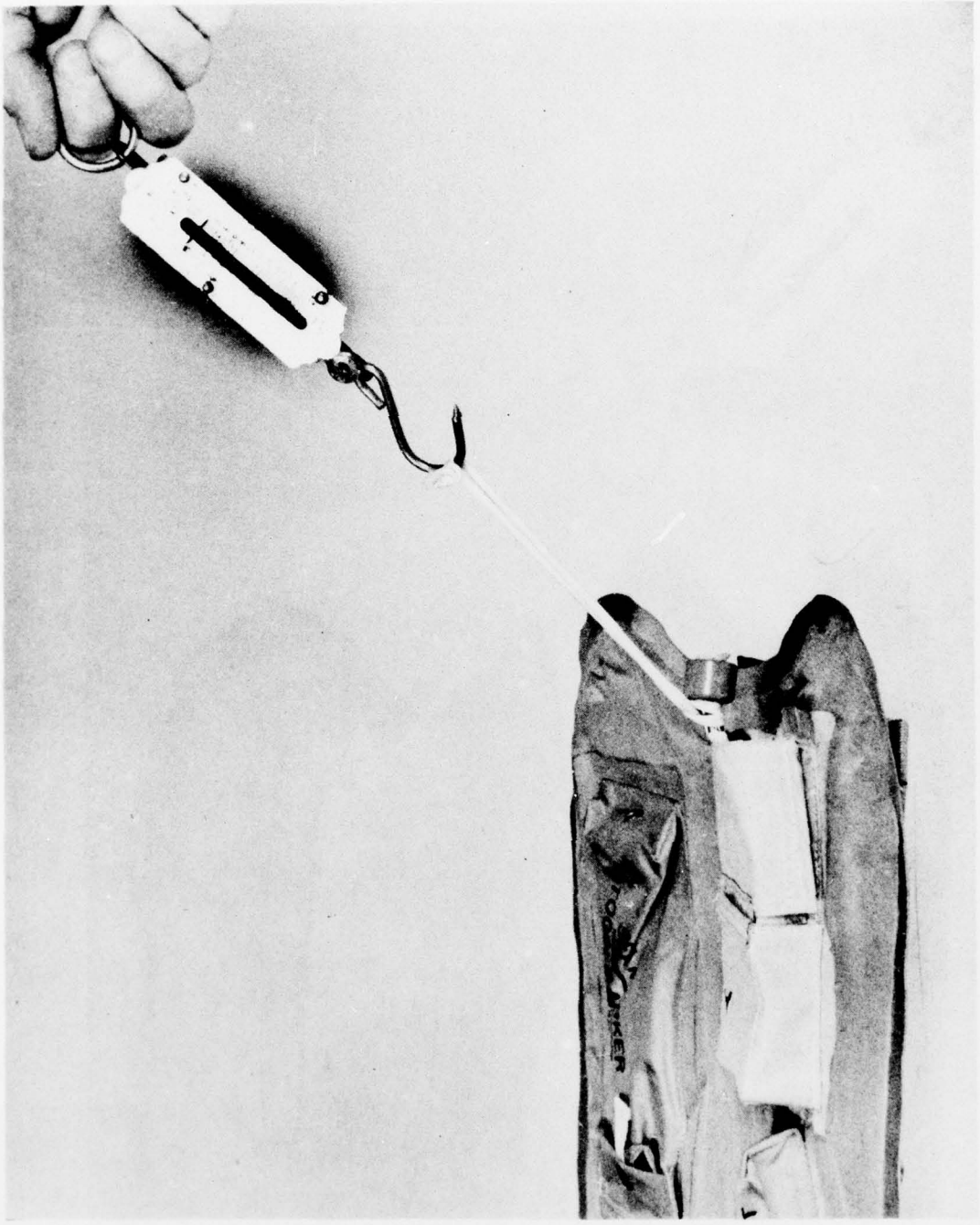

Figure 8: Pull force tests with spring balance (pocket A).